10	Q3	5.5
50	Q4	34
10	Q5	7.5
20	Total	~~11.9~~ 13.8

EE292.2
Electrical Engineering Lab I

Instructors:
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MIDTERM EXAMINATION

Date: February 26, 2003
Time: 7:00pm-9:00pm
Room: 2C40, 2C44

Name: _____

Stud. #: _____

Allowed: Lab books, calculator

Name: _____
Stud. #: _____

HEALTH AND SAFETY

Q) "Occupational Health and Safety" is the prevention among workers of ill health caused by their working conditions. (**True**) of **False**? True

8

Q) List 3 legislative rights and 3 responsibilities of a worker in health and safety issue.

a. Rights: Voice concerns about Safety b. Responsibilities: report unsafe practices
Take a problem to Labour board if needed to.
Check on safety procedures whenever you wish without warning.
ensure employer aware of safety needed
Notify employer when safety guidelines are not being followed.

Q) For protection purposes, the resistance of the human body measured between the "perspiring hands of a worker" is considered to be:

a) 500,000Ω
(b) 1500Ω
c) 700,000Ω
d) 100Ω

Q) What is the shortest path for a current going through your body?

a. Hand-to-hand
(b. Ear-to-ear)
c. Leg-to-leg
d. Hand-to-tongue

Q) Assume you have witnessed an electrical accident (accidental electrocution) where the victim is unconscious but still contacting the electrical source. *Briefly* describe your *first* course of action.

First I would make sure its safe for me then try to remove the source from the victim with an insulating material such as dry wood or remove the victim from the source with an insulating material such as dry wood.

Q) Describe a safe working habit when working with electricity:

I'd insure if wire is live or not always assume live and take proper safety precautions

Q) Who is the primary source for development of safety standards for installation and manufacture of electrical equipment?

Canadian Standards Association (CSA)

Q) What is minimum ground fault current required to trip a standard Class A Ground Fault Circuit Interrupter (GFCI)? 5m A

Question 1: BJT amplifier

(a) Using the schematic diagram below, find R_E, R_C to obtain I_C=6mA and an AC gain of approximate 4.

$I_C = 6mA$

$V_B = 3V$

$V_E = 2.3V$

$R_E = \frac{V_E}{I_E} = \frac{2.3V}{6mA}$

$R_E = 383\Omega$

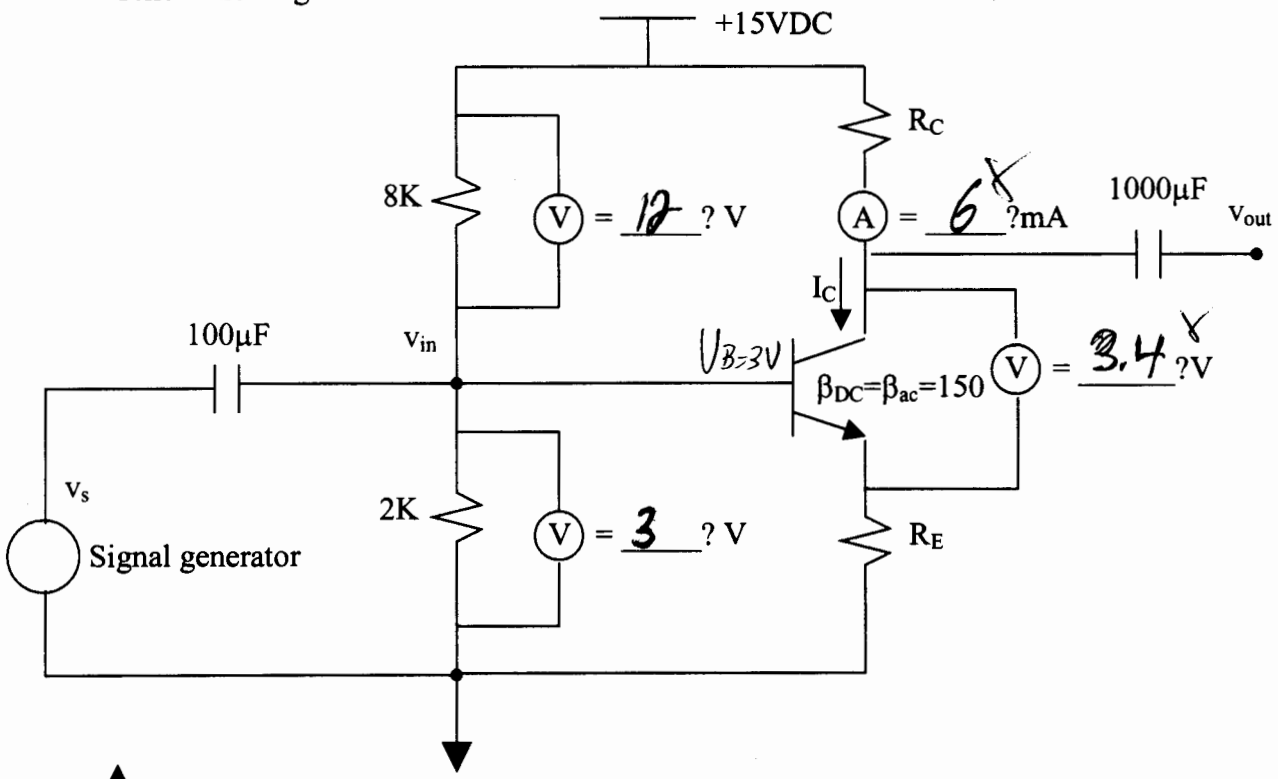
$AC\ gain = \frac{R_C}{r'e + R_E} \approx \frac{R_C}{R_E}$

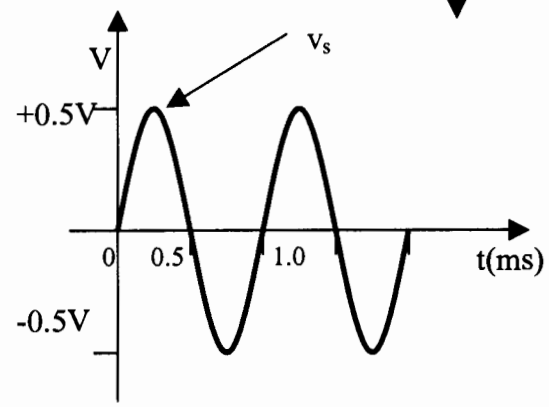
$r'e = \frac{0.02585}{6mA} = 4.3083\Omega$

$R_C = 4(383.3\Omega + 4.3\Omega) = 1.55k\Omega$

5

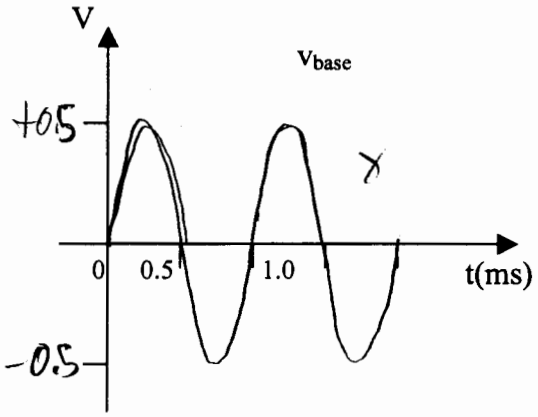
(b) The circuit was set-up with the resistors having –5% tolerance for resistances < 1K. Assume the voltmeters and ammeter having no error. Record DC bias voltages and current on the schematic diagram.

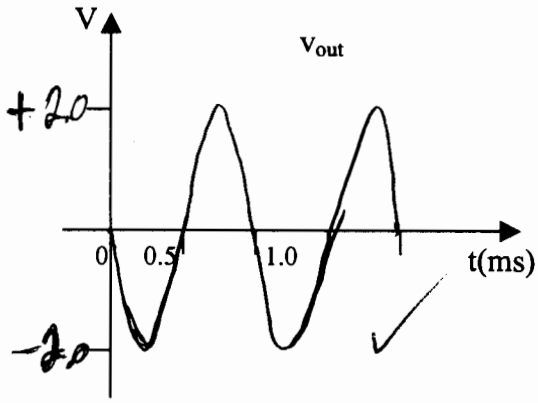




c) For the given waveform v_s from the signal generator, what is the amplifier gain (v_{out}/v_{in})? Sketch the waveforms (to scale) at the base and at the output with respect to ground.

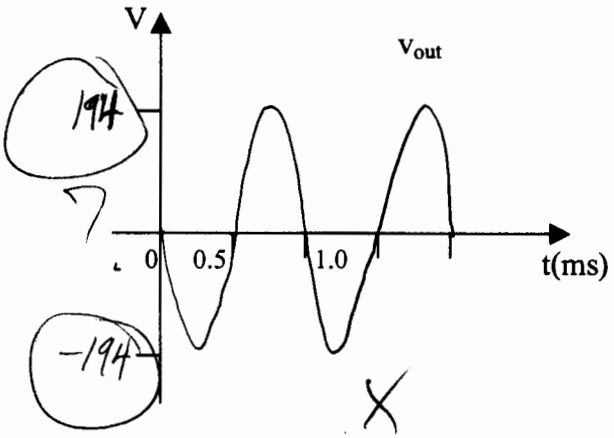
$\frac{V_{out}}{V_{IN}} = 4$ Inverting amplifier





d) Sketch the output waveform after your partner connects a 1μF capacitor across R_E.

$Gain = \frac{R_C}{R_e} = \frac{1.5K}{4} = 388$



8.5

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Stud. #: _____

Question 2: Basic measurement II

1. (a) If the capacitance of a series resonant circuit is increased, will the resonant frequency (a) increase (b) decrease? Why?

(1) resonant freq. will decrease b/c formula for f_r is $f_r = \frac{1}{2\pi\sqrt{LC}}$ so as C increases f_r will decrease.

(b) Calculate the Q factor of the circuit shown in Fig. 1. Find the resonant frequency. Draw the Q factor vs. frequency characteristic of this series R-L-C circuit.

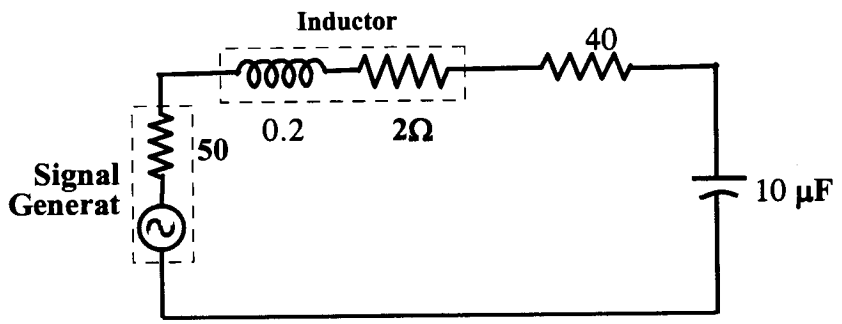
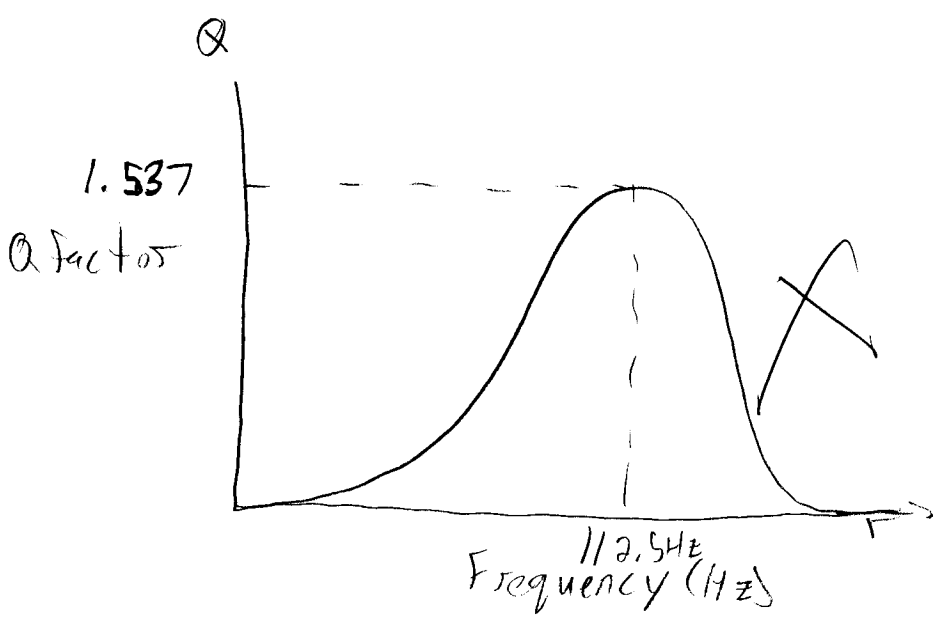


Fig. 1. Series R-L-C circuit.

(3) $f_r = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{(0.2)(10\times10^{-6})}} = 112.5\ Hz$

$Q = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{1}{92\Omega}\sqrt{\frac{0.2}{10\times10^{-6}}} = 1.537$



2. (a) A series resonant circuit has a resistance of 20Ω, and a bandwidth of 20 kHz at a resonant frequency of 1 MHz. Determine the required values of L and C.

$R = 20\Omega$ $\quad BW = 20\,KHz$

$BW = \frac{R}{L}$

$L = \frac{R}{BW} = \frac{20\Omega}{20\times10^3} = 1\times10^{-3} = 1mH$

$f_r = \frac{1}{2\pi\sqrt{LC}}$ → $C = \frac{1}{L}\left(\frac{1}{2\pi f}\right)^2$

$C = \frac{1}{(1\times10^{-3})}\left(\frac{1}{2\pi(1\times10^6)}\right)^2$

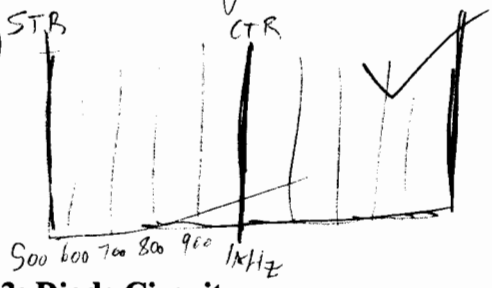
$C = 25.3\,pF$

2.5

(b) The display of the spectrum analyzer may be set to STR or CTR modes. What do STR and CTR stand for? If the display is set to STR mode, the LED display shows 500 Hz and the display sensitivity is set to 100 Hz/div, what would be the frequency corresponding to the center line of the display?

STR stands for start and CTR stands for center.
The freq at the center line wowd be 1KHz

2



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Question 3: Diode Circuits

1. (a) Find the rms value of the following rectified sine wave shown in Fig. 2 obtained by using a full-wave rectifier.

1

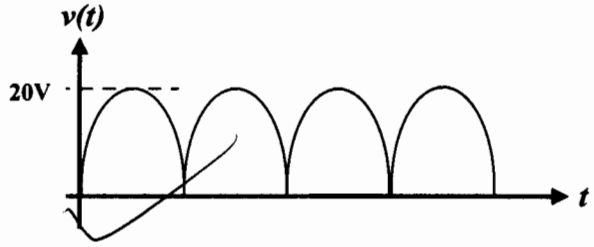


Fig. 2. Full-wave rectified voltage.

$20\sin(\omega t)$

$V_{rms} = \frac{20}{\sqrt{2}} = 14.14V$

(b) The voltage across resistor R_2 is zero in Fig. 3. Select the most likely causes from the following alternatives:

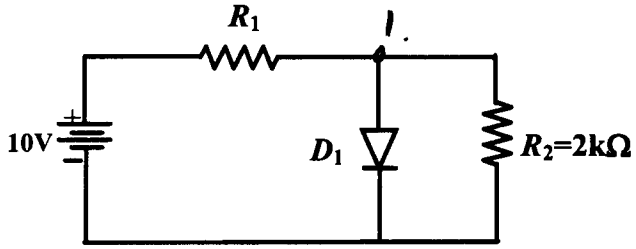


Fig. 3. Diode circuit.

i) resistor R_1 is open
ii) resistor R_2 is short
iii) diode D_1 is shorted
iv) resistor R_2 is open
v) diode D_1 is open

1.5

Explain your answer.

- If R_1 is open no current flows in the whole circuit.
- If D_1 is shorted all the current will flow through it so voltage across R_2 will be zero due to no current.
- If R_2 is open then Resistance is in effect = ∞ so no current will flow through R_2 which means no voltage.

(c) The voltage across R_2 in Fig. 3 is 6.67V. Normally it should be 0.7V. Indicate the most likely failure.

Most likely Diode D_1 is put in the wrong way so it is reverse biased rather than forward biased which would cause all the current to flow through R_2 creating a larger voltage drop across it.

1

2. (a) Consider a full-wave rectifier shown in Fig. 4 and the rectified output voltage shown in Fig. 5 (neglect the 0.7V drop across the diodes).

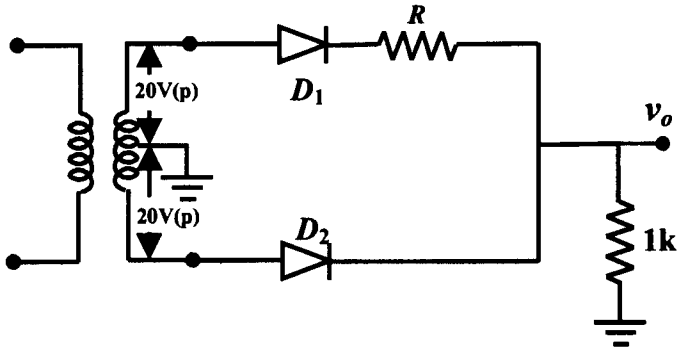


Fig. 4. Full-wave rectifier circuit.

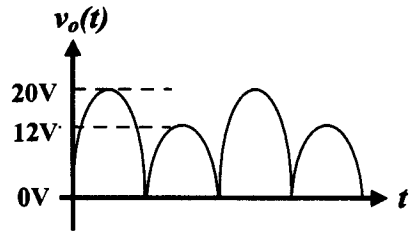


Fig. 5. Output voltage waveform.

(i) Calculate the value of resistance R.

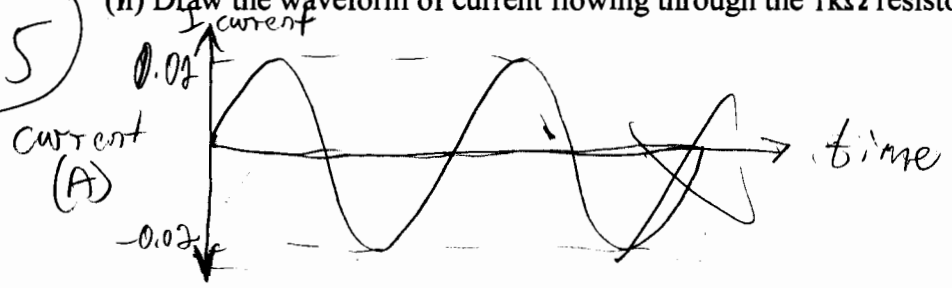
We need 8V drop across R.

$I = \frac{20V}{1K\Omega} = 2 \times 10^{-2} A$

$R = \frac{V}{I} = \frac{8V}{2 \times 10^{-2} A} = 400\Omega$

0.5

(ii) Draw the waveform of current flowing through the 1kΩ resistor.



(b) Draw the output voltage across R_L for the diode circuit shown in Fig. 6.

clipper (0-0.7V)

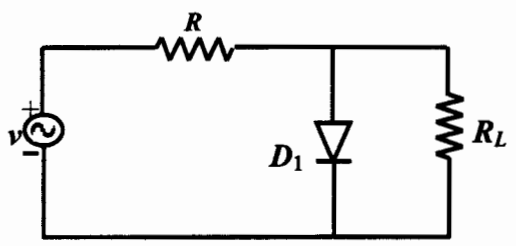


Fig. 6. Diode circuit.

1.5

Voltage will increase with D until it hits 0.7 then it will stay constant at 0.7 no matter how high V goes because once V > 0.7 at diode current flows right through then for negative cycle it will clip bic reverse biased diode.

Also, design a circuit that will produce the following output voltage waveform as shown in Fig. 7.

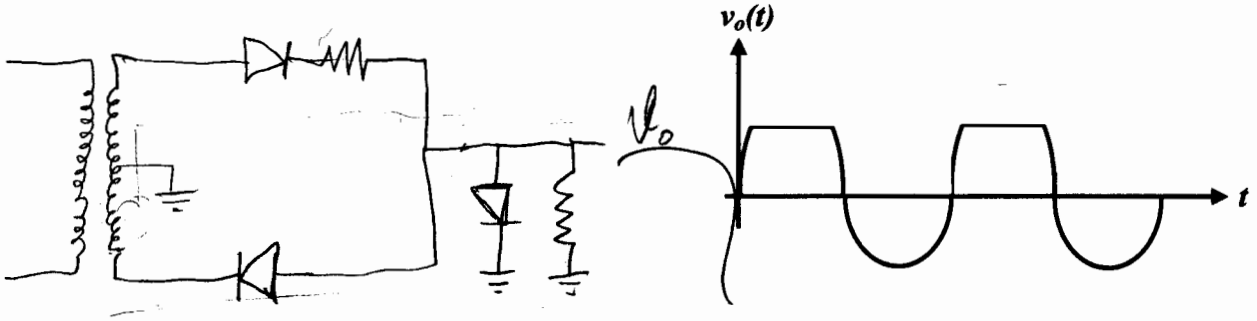


Fig. 7. Output voltage.

In this circuit will clip any voltages > 1.4 V as the current will flow through the diode at the end and when negative cycle flows all voltage will be dropped across the load resistor.

34/50

Name: _____
Stud. #: _____

Question 4: Diode and BJT Properties

1. (a) Are two series germanium diodes equivalent to one silicon diode?

Silicon diode ≈0.7V

~~Germanium~~ ≈ 0.3V or 0.4V

It depends, probably not though. (1)

(b) A Schottky diode has the *I-V* characteristic shown in Fig. 8, which you obtained in the lab:

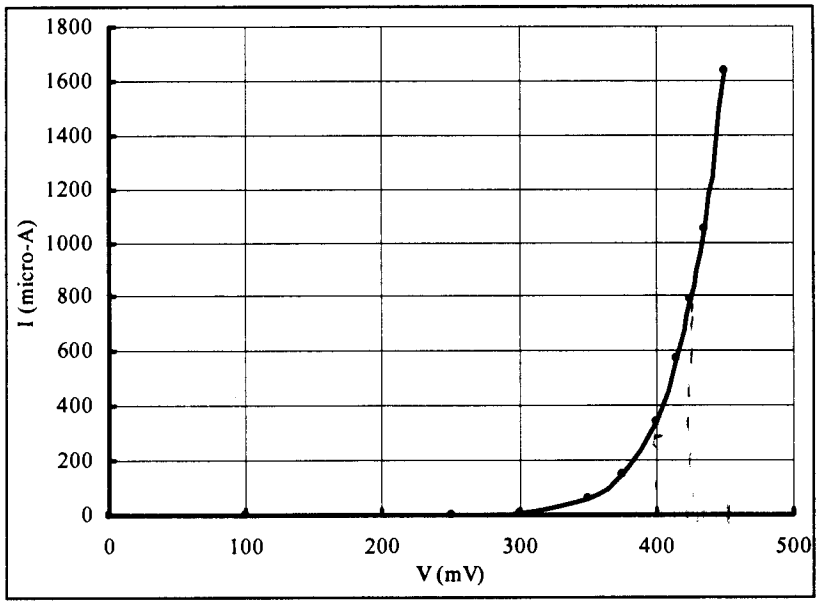


Fig. 8. Diode *I-V* characteristic.

i) What is the cut-in voltage of this diode? (3)

300mV, before that you have no current flow.

ii) Calculate diode constant *n*.

$$n = \frac{V_1 - V_2}{\ln(I_1) - \ln(I_2)} \frac{q}{kT} = \frac{428mV - 400mV}{\ln(800\times10^{-6}A) - \ln(300\times10^{-6}A)} \left(\frac{1}{0.026}\right)$$

$n = 1.349 \sim 1$ (5)

iii) Calculate the diode saturation current I_s.

$$I_s = \frac{I}{e^{\left(\frac{1}{0.026}\right)V\left(\frac{1}{n}\right)}} = \frac{800\times10^{-6}A}{e^{\left[\left(\frac{1}{0.026}\right)(428\times10^{-3})\left(\frac{1}{1.349}\right)\right]}}$$

$I_s = 4.00\times10^{-9}A = 4nA$ (5)

2. (a) Consider the following BJT circuit shown in Fig. 9. The circuit operates in the saturation region (ignore the Base-Emitter drop).

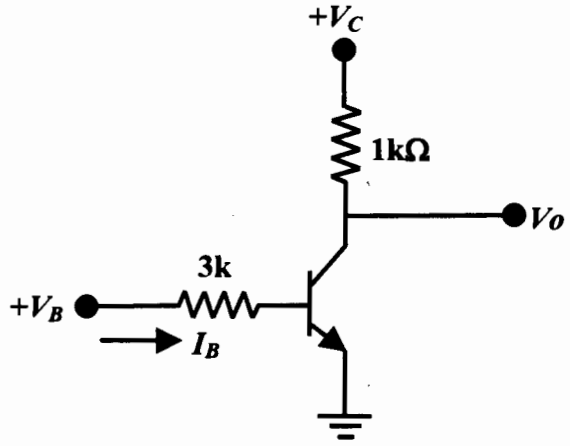


Fig. 9. BJT circuit.

(i) Calculate V_o and I_B when V_{BB}=0 V.

$V_{BB}=0V$, $I_B=0A$

V_o will be $=0V$

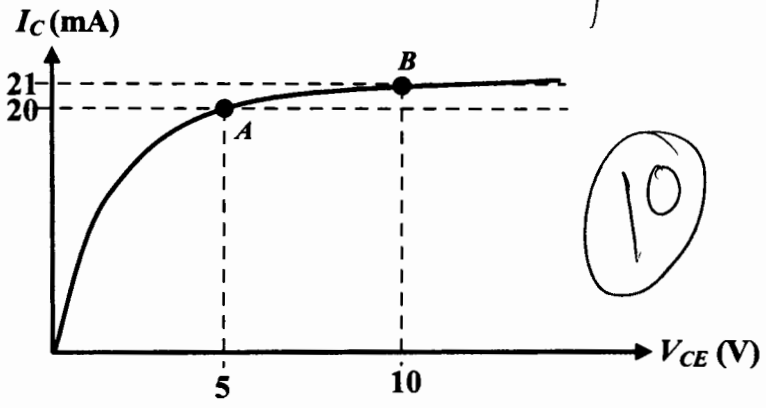
circuit will be in cut off region with $I_B=0$

(ii) Calculate V_o and I_B when V_{BB}=5 V.

$I_B = \frac{V_{BB}}{R_B} = \frac{5V}{3K\Omega} = 1.67\times10^{-3}A = 1.67mA$

10

(b) Figure 10 shows one of the collector curves. Calculate β_{dc} at points *A* and *B*.



10

Fig. 10. Collector characteristic.

$\beta_{DC} = \frac{I_C}{I_B}$

$= \frac{20mA}{1.67mA}$

$\beta_{DC} = 11.98$

$\beta_{DC} = \frac{I_C}{I_B}$

$= \frac{21mA}{1.67mA}$

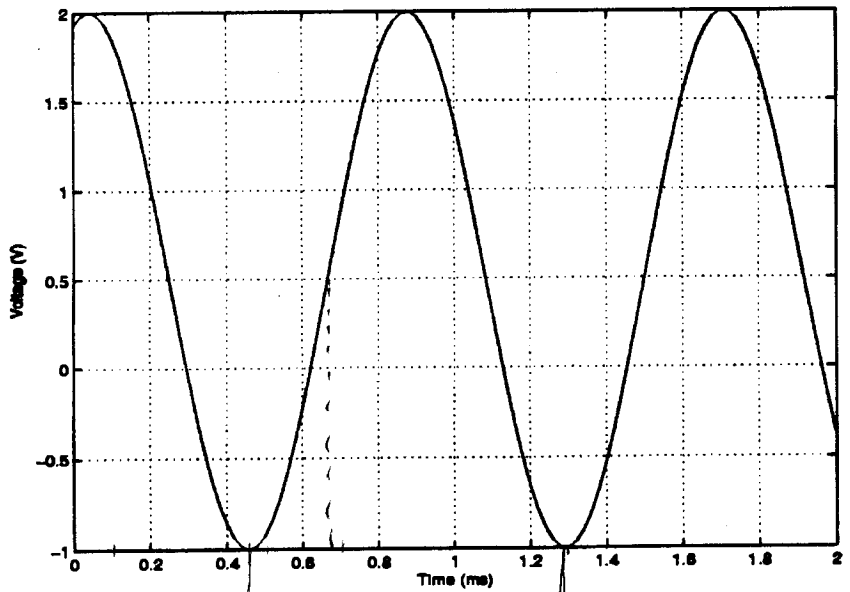
$\beta_{DC} = 12.57$

Name: _____

Stud. #: _____

Question 5: Basic Measurement I

Assume that the voltage v(t) across a 10Ω resistor is as shown below. Find the frequency, phase, magnitude and dc offset of the voltage waveform. Calculate the RMS value of the voltage, and the average power dissipated in this resistor.



$T = 1.3mS - 0.45mS = 8.5 \times 10^{-4} S$

- $f = \frac{1}{T} = \frac{1}{8.5 \times 10^{-4}} = 1176.5\ Hz$ ✓

- DC offset is: +0.5V ✓

- phase magnitude $\Rightarrow \frac{0.68mS}{(8.5 \times 10^{-4})} = \frac{\theta}{360°}$

$\theta = -288°$

$\theta = 72°$ ✓

$V_{RMS} = \frac{3.0V}{2\sqrt{2}} = 1.06V$

$I_{RMS} = \frac{1.06V}{10\Omega} = 0.106A$

$P = (0.106A)^2 (10\Omega) = 0.112\ W$

7.5